Name of Faculty: Amrendra kumar Amar

Designation: Asst.Prof

Department: Mechanical Engineering

Subject: Turbomachinary

Unit: Fifth (Fluid System)

Topic: Hydraulic lift

HYDRAULIC LIFT

- Hydraulic lift is a device used for carrying passenger or goods from one floor to another in multi-storeyed building. Hydraulic lifts are of two types, namely,
  1. Direct acting hydraulic lift
  2. Suspended hydraulic lift.
- **Direct Acting hydraulic lift:-** It consists of a ram, sliding in fixed cylinder as shown in fig.5.1. At the top of the sliding ram, a cage (on which the persons may stand or goods may be placed) is fitted. The liquid under pressure flows into the fixed cylinder. This liquid exerts force on the sliding ram, which moves vertically up and thus raises the cage to the required height. The cage is moved in the downward direction, by removing the liquid from the fixed cylinder.

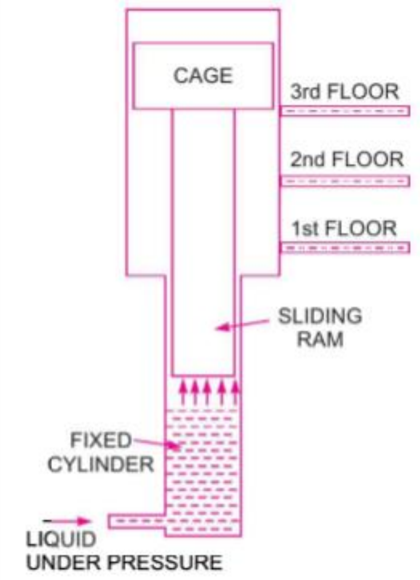

Fig. 5.1: - Direct Acting Hydraulic Lift

- **Suspended Hydraulic Lift :-** In Fig 5.2 we shows the suspended hydraulic lift. It is a modified form of the direct acting hydraulic lift. It consists of a cage (on which persons may stand or goods may be placed) which is suspended from a wire rope. A jigger, consisting of a fixed cylinder, a sliding ram and a set of two pulley blocks, is provided at the foot of the hole of the cage. One of the pulley block is movable and the other is a fixed one. The end of the sliding ram is connected to the movable pulley block. A wire rope, one end of which is fixed blocks and finally over the guide pulleys as shown in fig. The cage is suspended from the other end of the rope. The raising or lowering of the cage of the lift is done by the jigger as explained below.

  When water under high pressure is admitted into the fixed cylinder of the jigger, the sliding ram is forced to move towards left. As one end of the sliding ram is connecting to the movable pulley block and hence the movable pulley block moves towards the left, thus increasing the distance between two pulley blocks. The wire rope connected to the cage is pulled and cage is lifted. For lowering the cage, water from the fixed cylinder is taken out. The sliding ram moves towards right and hence movable pulley blocks also moves towards right. This decreases the distance between two pulley blocks and cage is lowered due to increased length of the rope.

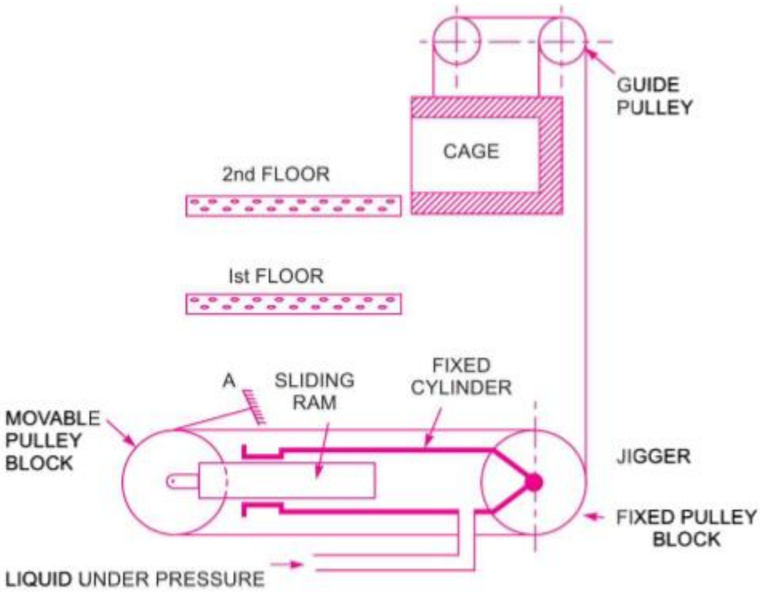

Fig- 5.2 Suspended hydraulic lift.

Q.no1:- A hydraulic lift is required to lift a load of 8 kN through a height of 10 meters, once in every 80 seconds. The speed of the lift is 0.5 m/sec. Determine : (i) Power required to drive the lift (ii) Working period of lifts in seconds, and (iii) Idle period of the lift in seconds.

Solution- Given :

Load lifted, $W = 8$ kN $= 8 \times 1000 = 8000$ N

Height, $H = 10$m

Time for one operation, $t = 80$ s

Speed of lift, $v = 0.5$m/s

(i) Work done in lifting the load in 80 seconds

$= W \times H = 8000 \times 10 = 80000$ Nm.

$\therefore$ Work done/sec $= 80000/80 = 1000$Nm/s

$\therefore$ Power required to drive the lift $= 1/1000 \times$ Work done/sec

$= 1/1000 \times 1000 = 1.0$ kW.

(ii) Working period of the lift $= \dfrac{Height\ of\ the\ lift}{Velocity\ of\ lift} = \dfrac{10}{0.50} = 20$ sec.

(iii) Idle period of the lift = Total time – Working period of lift

= 80 – 20 = 60 sec. Ans

Q.No 2:- A hydraulic lift is required to lift a load of 12kN through a height of 10 m, once in every 1.75 minutes. The speed of the lift is 0.75 m/s. During working stroke of the lift, water from accumulator and the pump at a pressure of 400 N/cm^2 is supplied to the lift. If the efficiency of the pump is 8% and that of lift is 75%, find the power required to drive the pump and minimum capacity of the accumulator. Neglecting friction losses in the pipe.

Solution. Given :

Load lifted, $W = 12 \text{ kN} = 12 \text{ X } 1000 = 12000 \text{ N}$

Height, $H = 10 \text{ m}$

Total time for operation, $t = 1.75 \text{ min} = 1.75 \text{ X } 60 = 105 \text{ sec}$

Speed of lift, $v = 0.75 \text{ m/s}$

Water pressure from accumulator and pump,

$P = 400 \text{ N/cm}^2 = 400 \text{ X } 10^4 \text{ N/m}^2$

Efficiency of pump, $\eta_p = 80\% = 0.80$

Efficiency of lift, $\eta_l = 75\% = 0.75$

Work done by water (supplied from accumulator and pump) in raising lift per second

= Load lifted x Distance travelled per sec

= W x Velocity of lift

= W x V = 12000 x 0.75 = 9000 Nm/sec

∴ Use power $= \frac{Work\ done\ per\ second}{1000} = \frac{9000}{1000} = 9\ kW$

∴ Actual power supplied to lift $= \frac{Useful\ horse\ power}{\eta_l} = \frac{9.0}{0.75} = 12\ kW.$

The power 12 kW has been supplied by the pump and by accumulator to the lift.

Let P_1 = Output of the pump in kW

Then $(12 - P_1)$ = Output of the accumulator in kW ...(i)

Now, working period of the lift $= \frac{Height\ of\ lift}{Velocity\ of\ lift} = \frac{H}{v} = \frac{10}{0.75} = 13.33\ sec$

Idle period of lift = Total time – working period of lift

= 105 – 13.33 = 91.67 sec

Thus during idle period of lift, the energy will stored in the accumulator and during working period of lift of 13.33 sec, the energy will be supplied by the accumulator to the lift.

∴ Energy stored during idle period in accumulator

$$= \frac{(P^1 x\ 1000\ )\ x\ 91.67}{13.33}\ Nm/sec$$

∴ Power supplied by accumulator = $\frac{1}{1000}$ [Energy supplied by accumulator/sec]

$$= \frac{1}{1000}\left[\frac{P^1 \times 1000\ \times 91.67}{13.33}\right] = 6.877 P_1$$

But from equation (i), power supplied by accumulator is also

$= (12 - P_1)$

∴ Equating the two values of power supplied by accumulator,

$6.877\ P_1 = 12 - P_1$ or $6.877\ P_1 + P_1 = 12$ or $7.877\ P_1 = 12$

∴ $P = \frac{12}{7.877} = 1.523.$

But we have assumed P_1 as the output of the pump.

∴ Input to the pump $= \frac{Output}{Efficiency\ of\ pump} = \frac{P_1}{\eta} = \frac{1.523}{0.80} = 1.90375\ kW.$

(i) ∴ power required to drive the pump = 1.90375 kW.Ans

(ii) Minimum capacity of the accumulator.

From equation (ii), the energy stored in accumulator

$= P_1 \times 1000 \times 91.67$ Nm

$= 1.523 \times 1000 \times 91.67$ Nm (∵$P_1 = 1.523$)

The capacity of the accumulator means the amount of hydraulic energy energy stored in the accumulator.

∴ Minimum capacity of accumulator = Energy stored = 139613.4 Nm. Ans